



# ADVANCED MATERIAL SOLUTIONS FOR LI-ION BATTERY APPLICATIONS

*Innovative Materials built from  
Decades of Automotive Expertise*



## Corporate Stats<sup>1</sup>

2018 Pro Forma Net Sales of **\$49.7B**

**113** manufacturing sites in **31** countries

Serving customers in **~160** countries



### OUR AMBITION

To become the most innovative, customer-centric, inclusive and sustainable materials company in the world

### OUR GOAL

Profitable growth & best-in-class performance

### OUR CORE VALUES

Integrity  
Respect for people  
Protecting our planet

# STREAMLINED AND FOCUSED PORTFOLIO

## RE-ALIGNED BUSINESSES

- Ag
- Electronic Materials
- Water
- Microbial Control
- Food & Pharma
- Auto Adhesives
- Building Solutions
- Silicones (aligned with SpecCo market verticals)
- Hemlock JV

**>\$12B Sales**

## DIVESTED BUSINESSES

- Chlor-Alkali (Americas)
- Epoxy
- Chlorinated Organics
- Angus Chemical
- Sodium Borohydride
- AgroFresh

**~\$2B Sales**

## RETAINED BUSINESSES

- Home & Personal Care
- Coatings & Monomers
- Polyurethanes (incl. Europe CAV, Construction Chemicals)
- Industrial Solutions
- Packaging & Specialty Plastics
- Hydrocarbons & Energy

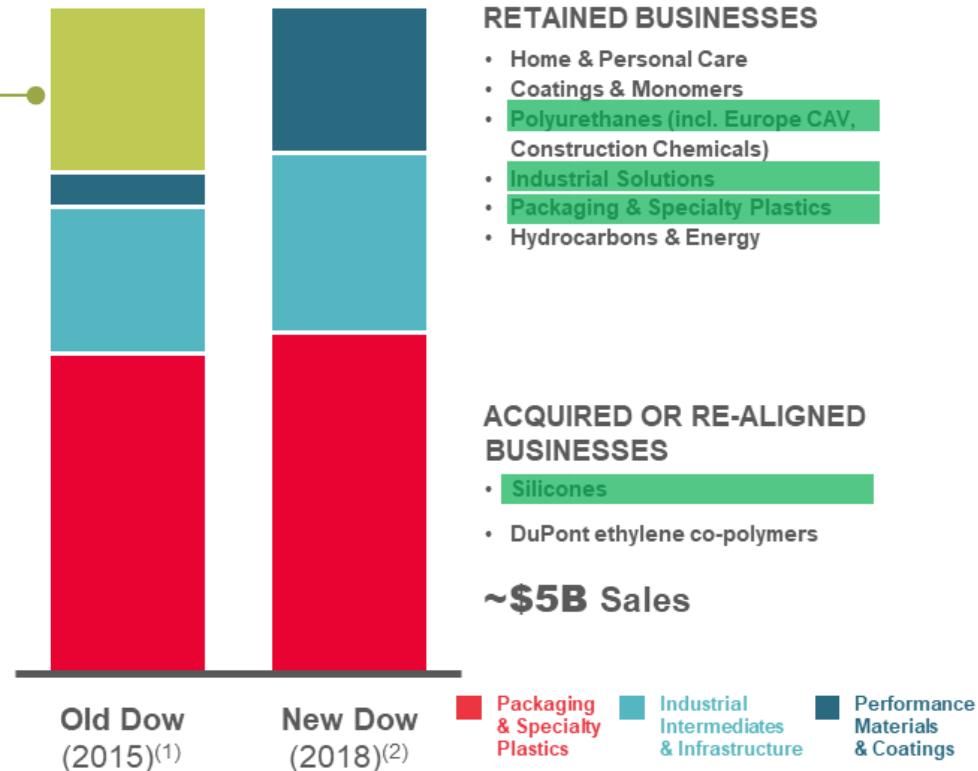
Relevant for EVs

Went to DuPont

## ACQUIRED OR RE-ALIGNED BUSINESSES

- Silicones
- DuPont ethylene co-polymers

**~\$5B Sales**



**Dow has a strong portfolio to support e-mobility**



# DOW: INNOVATION THAT DRIVES COMMERCIAL VALUE

## BUILDING BLOCKS

Advanced Back-Integration



Acrylics



Propylene Oxide



Ethylene Oxide



Polyolefins and Elastomers



Silicones

## CAPABILITIES

World-Class Science and Engineering Capabilities



High-Throughput Research



Catalyst Discovery  
& Ligand Synthesis



Polymer Science



Materials Science



Formulation Expertise



Process Engineering



High-Performance  
Computer Modeling



Application Development



Product Safety

## SOLUTIONS

Narrower, Deeper End-Market Presence



Packaging



Infrastructure



Consumer Care

# Advanced Material Solutions for Battery

## CHALLENGES

- Safety & reliability
- Energy density
- Thermal management
- Cost effectiveness

## SOLUTIONS

### Encapsulants

Light weight, cables protection, dielectric encapsulation and vibration absorption

### Thermally conductive gap filler

High thermal conductivity, low density, low thermal resistance and enhanced elongation

### CFRP housing

Fast Processing, Lightweight

### Foam

Fire protection and vibration absorbing thermal insulation foam

### Conformal Coatings

Waterproof, Dustproof, Anti-static

### Cell Cushion in Battery Pack

Space release and Vibrations dampen

### Coolant fluid

Improved battery pack heat dissipation

Adhesives

PU Foam

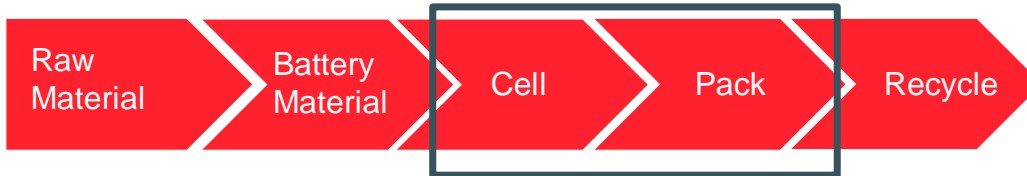
Fluids

Plastics

Coatings & Gels



# NORDEL® EPDM Cushion



## APPLICATION

- EPDM for space release and vibrations dampen between cells in battery pack

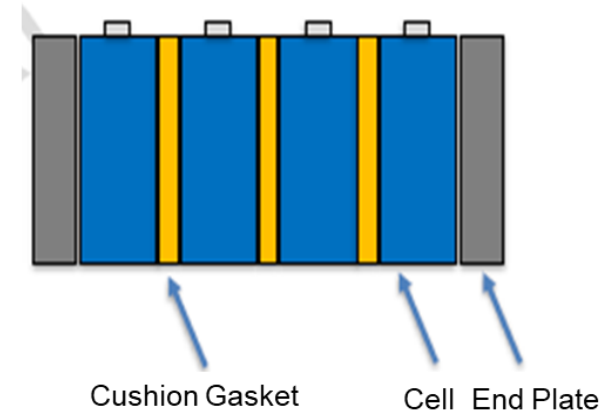
## TECHNOLOGY & ADVANTAGE

- **NORDEL® EPDM based cushion gasket**
  - ✓ Low hardness & low compressive modulus
  - ✓ Excellent mechanical strength
  - ✓ Adjustable flame resistance: UL94 HB to UL94 V0
  - ✓ Outstanding water and moisture resistance
  - ✓ Broad service temperature : -40 °C to 150 °C

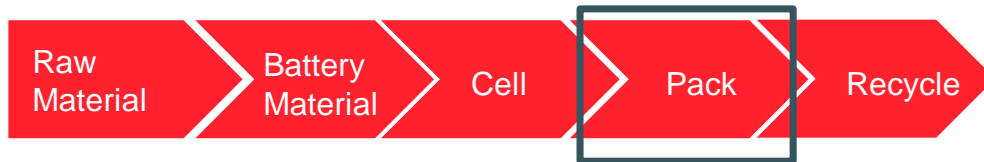
## BENEFITS

- Lower cost with balanced performance
- Safer battery pack

## Battery Cushion Gasket



# Lightweight Composite



## APPLICATION

- Composite to replace current Al case of battery pack

## TECHNOLOGY & ADVANTAGE

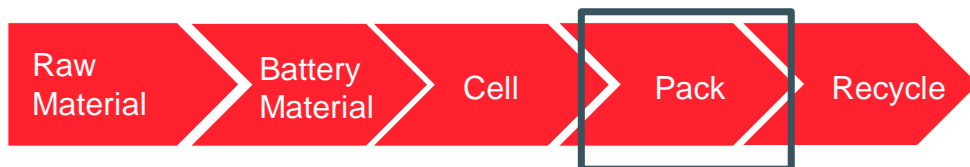
- **PCM (Prepreg compound molding)**
  - ✓ High mechanical strength
  - ✓ Good de-moulding performance
  - ✓ Long storage time at RT
  - ✓ UL94V0
- **HPRTM (High pressure resin transfer molding)**
  - ✓ High productivity within 3-5min curing
  - ✓ Low production cost
  - ✓ High mechanical strength
  - ✓ UL94 V0

## BENEFITS

- Lightweight, mass reduced up to 40%
- Flexibility of design
- Higher pack energy density



# Silicone Gap Filler



## APPLICATION

- Thermal gap filler to replace thermal pad between battery module and bottom box

## TECHNOLOGY & ADVANTAGE

- **2 parts silicone gap filler**
  - ✓ Low modulus
  - ✓ Low density
  - ✓ Extremely low thermal resistance
  - ✓ Good flame retardant property(UL-94 V0)

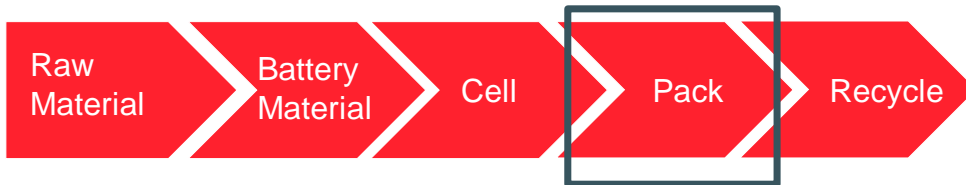
## BENEFITS

- Ease for automation
- Lightweight and higher energy density
- Low total cost in use





# Conformal Coating



## APPLICATION

- Thin protective film / breathing membrane that filters water vapor & solid debris in BMS

## TECHNOLOGY & ADVANTAGE

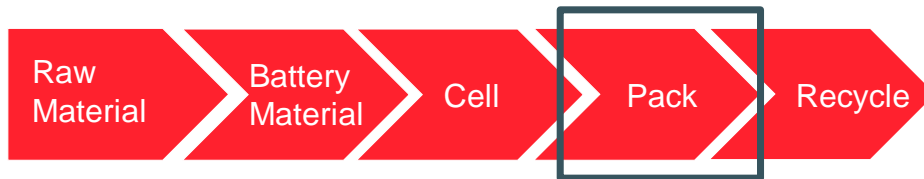
- **Silicone conformal coating**
  - ✓ Stress relieving and good protection
  - ✓ Good performance between -45°C to 200°C
  - ✓ Protects insulation resistance
  - ✓ Reduces conductor spacing on PCBs
  - ✓ Good dielectric properties (insulation, moisture resistance, breakdown voltage)

## BENEFITS

- Long term reliability
- Process design feasibility



# Silicone Foam



## APPLICATION

- Silicone Gasket for EV battery Pack Sealing

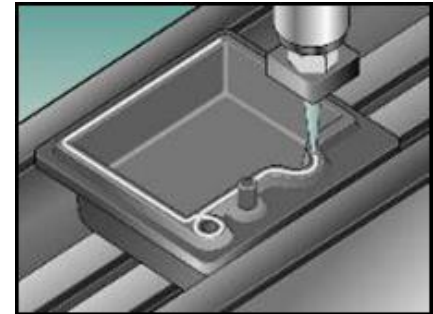
## TECHNOLOGY & ADVANTAGE

### Silicone Foam as Gasket

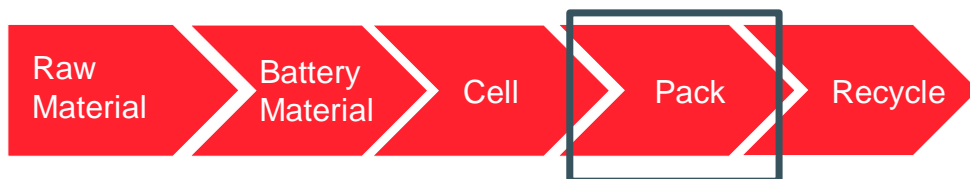
- ✓ Broad silicone gasket solution with proved performance  
FIPG (Formed In Place Gasket); CIPG (Cured In Placed Gasket);  
DFG (Dispensed Foam Gasket)
- ✓ Fit for automatic production
- ✓ Excellent reliability after aging

## BENEFITS

- Industrial 4.0, Improved production efficiency
- Low total cost in use



# Potting Materials



## APPLICATION

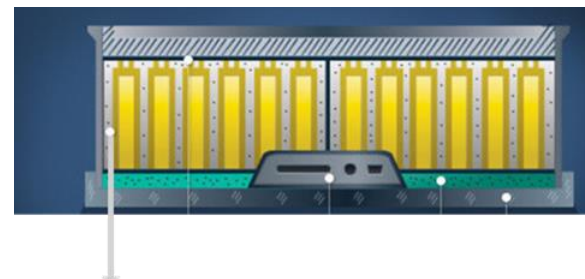
- Differentiated silicone-organic pottant solution for battery protection

## TECHNOLOGY & ADVANTAGE

- **Silicone or Si-organic pottant**
  - ✓ Balance of performance and cost
  - ✓ Low stress and modulus
  - ✓ Non-toxic and no odor
  - ✓ Good performance between -45°C to 150°C

## BENEFITS

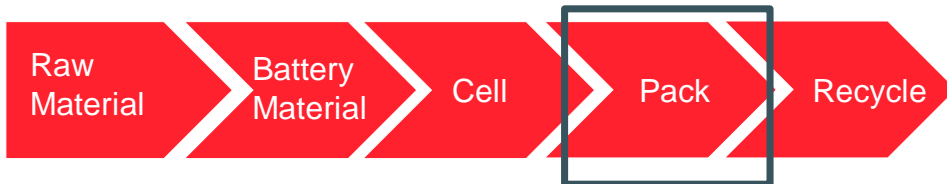
- Lower cost with balanced performance
- Safer battery pack



Pottant Materials



# Coolant Fluid



## APPLICATION

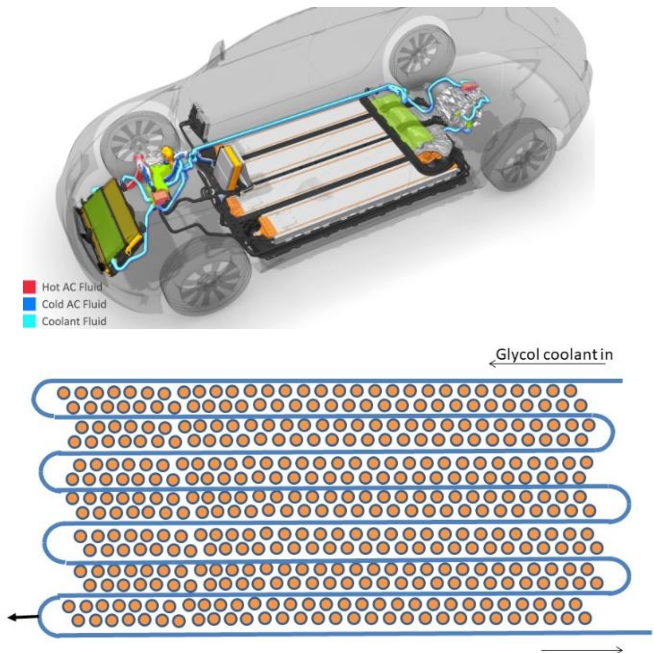
- Unique inhibitory glycol for cooling of whole battery pack

## TECHNOLOGY & ADVANTAGE

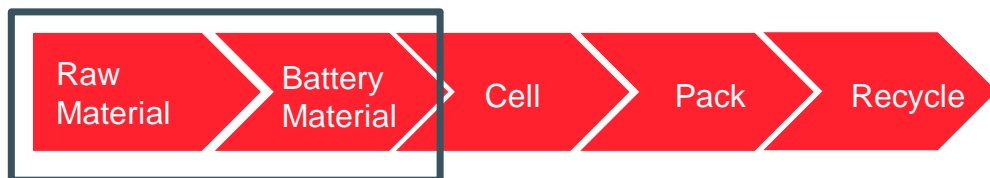
- **Glycol coolant**
  - ✓ Customize for power battery
  - ✓ Excellent cooling performance
  - ✓ Wide temperature working window
  - ✓ No scale generated

## BENEFITS

- Long term reliability
- Safer battery pack



# Dispersant & Rheology Modifier for Ceramic Coating on Separator



## APPLICATION

- Dispersant & Rheology for Ceramic Coating on Separator

## TECHNOLOGY & ADVANTAGE

### Dispersant

- ✓ High dispersing efficiency
- ✓ Low metal ion content
- ✓ Hydrophobic dispersant for low water residual in ceramic coating
- ✓ Maintain viscosity during ceramic slurry storage
- ✓ Compatible with other additives and binders

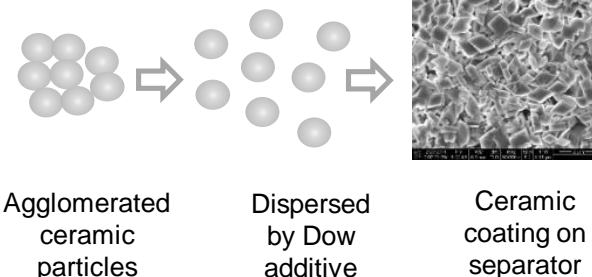
### Rheology modifier

- ✓ High thickening efficiency
- ✓ Excellent association with binder for uniform ceramic coating
- ✓ Hydrophobic modified for low water residual in ceramic coating
- ✓ Meet different processing: leveling, mixing and high speed coating

## BENEFITS

- Short cycle time
- Uniform performance
- Flexible process choices

## Dispersant



## Rheology modifiers

Process	Shear Rate						
	10 <sup>-2</sup>	10 <sup>-1</sup>	10 <sup>0</sup>	10 <sup>1</sup>	10 <sup>2</sup>	10 <sup>3</sup>	10 <sup>4</sup>
Levelling	Red bar						
Dip coat			Red bar				
Pumping			Red bar				
Mixing				Red bar			
Dispersing				Red bar			
Spray coat					Red bar		
Roller coat					Red bar		
Blade coat					Red bar		





Seek

Together™